

### Materials per Team

- round balloons
- soft-tipped markers

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# The Big Bang

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## *An Expanding Universe*

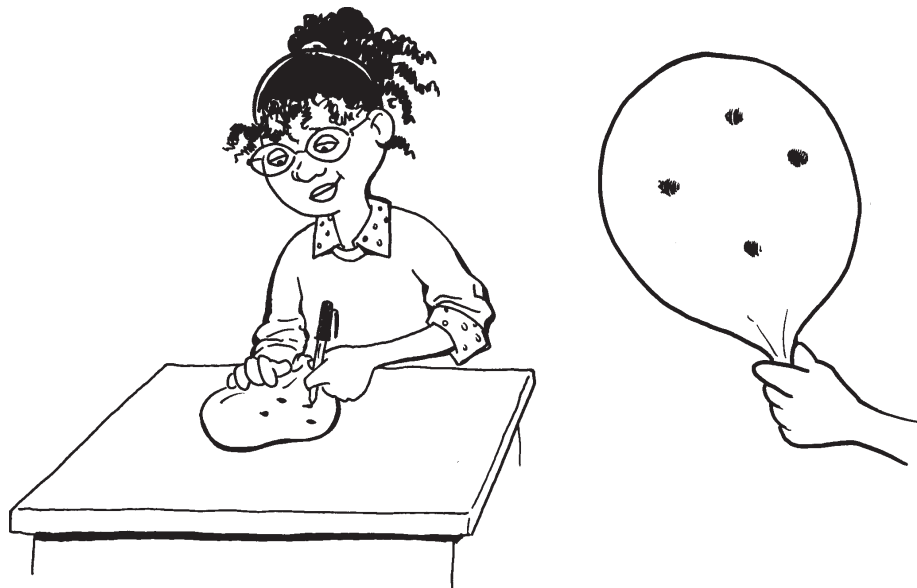
This activity has two parts. The first illustrates the movement of matter away from the site of the so-called Big Bang, a primeval occurrence scientists theorize may have formed the universe. The second simulates how wavelength changes as objects move in relation to each other.

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### Activity 1

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To illustrate the concept of an expanding universe, use balloons to simulate movement in all directions from a central beginning point. Have students make small dots on the surface of uninflated balloons. As they blow air into the balloons, ask them to observe how the dots move away from each other and from the center of the balloon. The dots may represent stars or galaxies of stars.



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## Activity 2

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When objects move away from us, the waves we receive from them seem to lengthen. That is, the distance between the peaks of the waves spreads out because their source is receding. This is similar to the Doppler effect in sound waves. The pitch of a train whistle or emergency vehicle siren seems to change as it moves either toward or away from the listener.

Students can simulate this lengthening or shortening of waves. Designate one person as a receiver on Earth. Group another few students several steps away to represent the waves from a star. Ask one person from the star to walk toward the receiver at a constant rate while the rest of the group takes a step back in the other direction. Each time the star group recedes a step, another wave heads toward Earth, walking at the constant rate.



After repeating this process several times, students will note how much longer the waves are taking to reach the receiver and how the distance between the waves has increased. If the waves were light waves, the receiver would see a color shift. If they were sound waves, the pitch would change. Edwin Hubble used this method to theorize that the universe is expanding.



## READING:

# *The Origins of the Universe*

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**H**ow did the universe begin? Imagine designing a laboratory or classroom experiment to answer that! **Cosmology** is the name of the branch of science or philosophy that seeks to explain the origins of the universe. For as long as humans have recorded history, people have tried to follow time back to its beginnings. In modern scientific societies, the search continues.

Strangely, or perhaps not so strangely, the study of the very smallest components of matter lead scientists to discoveries about the very vastness of the universe. The huge amount of energy that can be released from tiny atoms suggests theories about a possible “Big Bang” origin of the universe. Perhaps an explosion occurred when all matter was once densely packed in an incredibly small area.

Every culture seems to have a version of how the Earth and sky were created. You have probably read creation stories from cultures around the world. Ask your librarian or teacher to help you find a few and compare the various stories.



The ancient Greeks, Arabs, and Chinese, especially, studied the skies intensely. The Egyptian pyramids and prehistoric stone monuments such as Stonehenge in England line up with **astronomical** positions. Scientists continue to study these impressive ancient achievements to learn how much people knew about the universe. Eratosthenes (276–195 B.C.) estimated the size of the Earth fairly accurately by comparing shadow lengths in two places on the same day. He reasoned that the difference in shadows indicated that the Earth was not flat, but spherical.

Much of the knowledge of the ancients was lost or ignored for centuries. Superstition and **dogma** (a set of ideas to be believed) dominated people’s view of the universe. European science began to come alive again in the fifteenth and sixteenth centuries. During this time, which became known as the **Renaissance**, the stubbornly held idea of the Earth as the center of the universe began to be challenged.

Edmond Halley (1656–1742) explained comets and their long journeys. Comets orbit the sun but travel far beyond the outer

planets on their journeys. Not only was the Earth's position as the center of the universe challenged, but its size was becoming ever more like that of a tiny seed afloat in a vast ocean.

In 1912 American Henrietta Leavitt (1868–1921) devised a method of measuring the distance of certain stars from Earth. These **Cepheid variable stars** change brightness over a period of time. Leavitt determined that the **Magellanic Clouds** are far beyond our galaxy. In 1929, fellow American Edwin Hubble (1889–1953) built upon her discoveries and proposed that the universe is not only bigger than Leavitt proved but that it is expanding.

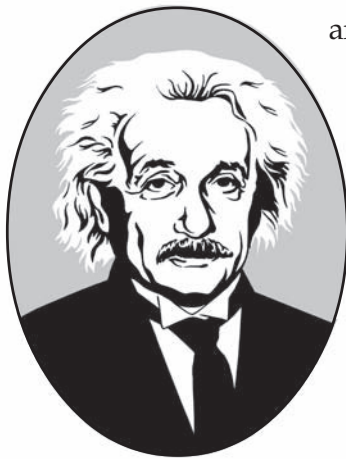
Hubble reasoned that the **wavelength** of light received on Earth indicated that stars and galaxies were moving rapidly away from our planet. Since the nineteenth century, starlight could be broken into a **spectrum**, or rainbow. The spectrum's pattern can be analyzed to determine the chemical elements that make up the star. Hubble used the stars' light to determine that they are racing away from Earth.

Hubble's findings corroborated a 1927 theory of Belgian Georges Lemaître (1894–1966). Lemaître proposed that the universe was born in a great explosion, or Big Bang. By the later part of the twentieth century, most cosmologists had accepted the Big Bang theory. All the mass of the universe was packed into a tiny space and an unimaginably powerful explosion sent matter on its way. The universe is calculated to be more than ten billion years old, so the galaxies have been speeding away from each other for a long time.

Albert Einstein (1879–1955) connected mass and energy with his famous equation,  $E = mc^2$ , which means: Energy equals mass times the speed of light squared, or the speed of light multiplied by itself.

Einstein proposed several remarkable theories and many important concepts came from them. For example, he claimed that gravity could affect light, and he was proven to be correct. His view of the universe was of a vast and expanding space with time as a fourth dimension.

What will be added to this modern creation story as more discoveries occur in the years to come?



Albert Einstein

## Vocabulary Words

astronomical ..... having to do with objects outside the Earth

Cepheid variable star ..... giant stars that display a cycle of varying brightness

cosmology ..... that branch of science that deals with the creation and evolution of the universe

dogma ..... a set of ideas to be believed

Magellanic Clouds ..... galaxies that are visible from the Southern Hemisphere

renaissance ..... a revival; a reawakening of cultural achievement

spectrum ..... sequence or range of energy by wavelength

wavelength ..... distance between identical parts of waves, such as the distance between crests or between troughs

